MANAGEMENT

An Analysis of Cost trends for Southern Forestry Practices

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Abstract—Costs of forestry practices have been reported periodically for the South for over 60 years, with few analyses of the cost trends. We report on an analysis of these trends between 1982 and 2016, including indices for overall costs and labor costs for forest management. The overall cost of intensive silviculture in the South, as measured by the southern forestry practices cost index (SFPCI), changed little; however, some practices experienced increases in real costs, while other costs changed little or declined slightly. Correlations between forestry wages and/or other variable cost components were identified for several practices and for the SFPCI. Results indicate that changes in the costs associated with practicing forestry in the South often correlate with changes in labor and fuel costs. Additional research could explore the effects of forestry practice cost change on the profitability of timber management scenarios.

INTRODUCTION

Pine plantation silviculture in the South saw remarkable growth in the second half of the 20th century, with planted pine acreage increasing from 1 percent to 15 percent of the region's timberland area (Conner and Hartsell 2002). Relative forest productivity also greatly increased, with the mean annual increment of pine plantations in the South more than doubling and average rotation lengths being cut in half (Fox and others 2007). In addition to improvements in rearing and breeding superior pine seedlings, much of this increase in productivity can be attributed to the development and use of a variety of intensive forestry practices (Fox and others 2007). The intensive use of these practices has shown the potential to maximize timber production, while providing attractive economic returns (Borders and Bailey 2001). However, these practices can be costly and impact profitability.

Understanding the costs associated with timber production is crucial to analyzing the profitability of any given forest management regime. Since 1953, average forestry practices costs for the South have been periodically reported in Forest Landowner magazine (formerly Forest Farmer) using survey results from timber managers of both private and public forest land (Barlow and Levendis 2015). Table 1 lists these studies in chronological order.

The first trend analysis of this data, covering 24 years, occurred in 1982 and found forest practices costs rising substantially faster than both the price of lumber and the wholesale price index, suggesting that the cost of practicing forestry was outpacing inflation and any potential increase in the price of sawtimber (Moak 1982). Over 20 years later Bair and Alig (2006) concluded that the real cost of some major forestry practices used on private lands in the South had remained relatively constant between 1982 and 2002, with a few costs rising slightly.

Table 1—Forest Farmer/Forest Landowner forestry practices cost studies, 1953-2016

Study year	Year published	Volume/issue/ pages	Author(s)	Publication
1952	1953	12(8):5,17	Worrell A.C.	Forest Farmer
1961	1963	22(13):6-8,15	Somberg S.I., Eads L.D., Yoho J.G.	Forest Farmer
1967	1971	30(7):42-50	Yoho J.G., Dutrow G.F., Moak J.E.	Forest Farmer
1974	1975	34(5):74-82	Moak J.E., Kucera J.M.	Forest Farmer
1976	1977	36(5):16-21	Moak J.E., Kucera J.M., Watson W.F.	Forest Farmer
1979	1980	39(5):50-63	Moak, J.E., Watson, W.F., Deusen, P.V.	Forest Farmer
1982	1983	42(5):26-32	Moak J.E., Watson W.F., Watson M.S.	Forest Farmer
1984	1985	44(5):16-22	Straka T.J., Watson W.F.	Forest Farmer
1986	1987	46(5):28-34	Watson W.F., Straka T.J., Bullard S.H.	Forest Farmer
1988	1989	48(5):8-14	Straka T.J., Watson W.F., Dubois M.F.	Forest Farmer
1990	1991	50(3):26-32	Dubois M.F., Watson W.F., Straka T.J., Belli K.L.	Forest Farmer
1992	1993	52(3):25-31	Belli M.L., Straka T.J., Dubois, M., Watson, W.F.	Forest Farmer
1994	1995	54(3):10-17	Dubois M.R., McNabb K., Straka, T.J., Watson, W.F.	Forest Farmer
1996	1997	56(2):7-13	Dubois M.R., McNabb K., Straka, T.J.	Forest Landowner
1998	1999	58(2):3-8	Dubois M.R., McNabb K., Straka, TJ.	Forest Landowner
2000	2001	60(2):3-8	Dubois M.R., Erwin C.B., Straka, T.J.	Forest Landowner
2002	2003	62(2):3-9	Dubois M.R., Straka T.J., Crim S.D., Robinson L.J.	Forest Landowner
2004	2005	64(2):25-31	Smidt M.F., Dubois, M.R., Folegatti, B.S.	Forest Landowner
2006	2007	66(5):11-16	Folegatti B.S, Smidt M.F., Dubois M.R.	Forest Landowner
2008	2009	68(5):5-12	Barlow R.J., Smidt M.F., Morse J.Z., Dubois M.R.	Forest Landowner
2010	2011	70(6);15-24	Barlow R.J., Dubois M.R.	Forest Landowner
2012	2013	72(4):22-29	Dooley E., Barlow R.	Forest Landowner
2014	2015	74(5):22-31	Barlow R., Levendis W.	Forest Landowner
2016	2017	76(5):30-39	Maggard A., Barlow, R.	Forest Landowner

Source: Dubois and others 1995.

Moak (1982) suggested that in the early years of the Forest Farmer magazine survey the easier sites for practicing forestry had been utilized, and over time forest managers had to move on to more difficult and, thus, more expensive sites. Various authors have suggested that changes in both labor costs and fuel prices play a role in changes in the costs of forestry practices (Bair and Alig 2006, Moak 1982, Straka and others 1992). Until 1999, a cost component breakdown was included for each practice in the cost studies, which suggested that labor was often the most significant cost component for many or most practices, while equipment costs, which incorporated fuel costs, contributed substantially to the cost of mechanized practices such as site preparation (Moak and others 1980). Mills and others (1985) found a significant relationship between forestry practices costs on national forests and the number of people employed by the contractors hired to complete the treatments, further demonstrating the relationship between labor costs and silviculture practice costs. In the case of herbicide applications and fertilization practices, chemical and fertilizer costs have been noted as making up the most substantial portion of the cost of these practices (Belli and others 1993).

Little recent work has been done in the way of examining long-term trends in forestry practices costs and cost components. Even less has been done to examine these trends without the influence of inflation. Finally, no forestry cost trend analysis representing a substantial amount of time as well as both private and public forest management costs has incorporated the use of a southern forestry wage-based index or an index representing a basket of southern forestry practices. Thus, the objectives of this study were as follows:

(1) Estimate the real average annual rate of change for the cost of nine major forestry practices in the South.

(2) Establish a measure of the change in forest practices costs as a whole in the South, by creating a southern forestry practices cost index (SFPCI).

(3) Develop a southern forestry employee wage index (SFEWI) to estimate the change in forestry labor costs.

(4) Use the SFEWI, No.2 diesel fuel index, and herbicide and fertilizer indices in the detection of correlations between forestry practices costs and labor and/or fuel costs.

METHODS

Data were compiled from all forestry practices cost studies published in Forest Farmer and Forest Landowner magazines between 1953 and 2017. Only summary data for years starting with 1982 were used for calculations due to limited reporting for some major practices for years prior to that. These forestry practices costs are presented in table 2. The year 1982 also served as the base year for all indices used in this study.

The SFPCI was developed from eight major forestry practices; hand and machine tree planting were combined. That index, using methods developed in Dubois and others (1991), was based on an aggregate index of forestry practices that was weighted by the number of respective acres on which the practices were used for a base year. Using methods in Dubois and others (1991), 1988 was used as the weight base year due to the lack of availability of acreage data for some practices before that year. Values for SFPCI are presented in table 3.

The SFEWI was also developed using the methods in Dubois and others (1991) and used wage data obtained from the Bureau of Labor Statistics for average annual wages paid to timber tracts (SIC 0811 and NAICS 1131) and forestry services (SIC 0851 and NAICS 1153) for 13 Southern States, including Kentucky and Oklahoma, as an indicator of forestry employee wages (USDL Bureau of Labor Statistics 2017a). Wage datasets for 1982-2000 and 2002-2016 were combined to cover the relevant time period. Unlike Dubois and others (1991), cost and wage data representing both private and public entities were used to produce these indices in order to correspond with the Forest Farmer/Forest Landowner magazine studies, which published data provided by the full spectrum of southern timber managers. Values for SFEWI are presented in table 3.

In addition to cost and wage data, values for the Producer Price Index (PPI) and No.2 Diesel index were also obtained for the corresponding years as a means of providing a comparison between cost and price data, and in the case of the PPI, to provide a measure of inflation (USDL Bureau of Labor Statistics 2017b). The No. 2 Diesel price index and SFEWI were used to determine correlations between changes in forestry practices costs and changes in fuel price and labor respectively. In order to further investigate cost components for herbicide and fertilization practices, herbicide and fertilizer price indices were obtained from the (USDA National Agricultural Statistics Service 2018a, 2018b). These indices were only available starting in year 1990.

Table 2—Forest Farmer/Forest Landowner cost study summary values, 1982-2016

Year	Controlled burning	Herbicide application	Timber cruising	Tree marking	Mechanical site preparation	Hand planting[a]	Machine planting[a]	Pre-commercial thinning	Fertilization
					$ per acre (planting costs are $ per seedling)				
1982	4.12	40.56	2.18	14.02	114.04	0.0484	0.0540	49.27	38.8
1984	7.16	64.82	2.26	14.63	90.23	0.0485	0.0505	43.18	40.35
1986	4.84	65.61	3.27	10.57	94.21	0.0524	0.0439	54.44	36.03
1988	6.52	57.26	3.47	8.58	92.66	0.0584	0.0492	55.58	35.84
1990	8.1	63.7	2.02	8.47	87.45	0.0597	0.0452	55.43	39.29
1992	8.14	62.73	2.49	12.72	98.42	0.0577	0.0519	75.71	43.17
1994	10.57	67.41	2.09	14.19	100.74	0.0587	0.0592	79.05	41.01
1996	14.65	67.65	3.06	12.21	108.05	0.0607	0.0651	89.22	56.52
1998	16.58	72.32	4.1	15.06	122.14	0.0670	0.0593	71.27	54.8
2000	17.7	68.12	3.45	25.7	136.03	0.0641	0.0770	82.27	43.08
2002	14.41	70.18	5.4	65.09	166.5	0.0800	0.1100	102.1	56.04
2004	21.08	69.45	3.32	14.62	105.23	0.0668	0.1162	74.98	50.08
2006	24.94	79.41	5.23	58.26	119.72	0.0863	0.1168	58.89	77.98
2008	29.31	48.82	6.28	86.99	157.32	0.1079	0.1386	80.18	110.28
2010	25.79	47.68	6.56	48.4	139.95	0.1200	0.1500	166.66	62.79
2012	32.42	55.12	13.2	43.48	168.13	0.1100	0.2400	50.27	86.33
2014	18.18	29.89	2.75	29.64	95.78	0.1100	0.1400	—	79.49
2016	26.63	69.53	10.64	29.25	140.99	0.1200	0.0900	159.44	70.41

[a]Planting costs do not include seedling costs.
— = Not available.

Table 3—Values for the Southern Forest Practice Cost Index (SFPCI), Southern Forest Employee Wage Index (SFEWI) and wProducer Price Index (PPI), 1982-2016

Year	SFPCI	SFEWI	No. 2 Diesel Fuel Price Index[a]	PPI[a]
1982	100	100	100	100
1984	99	108	86	104
1986	96	111	49	100
1988	96	123	50	107
1990	97	134	74	116
1992	106	147	62	117
1994	109	157	56	120
1996	120	168	70	128
1998	131	169	47	124
2000	135	183	93	133
2002	169	186	78	131
2004	132	194	128	147
2006	158	225	217	165
2008	195	256	325	190
2010	174	256	233	185
2012	211	283	326	202
2014	114	295	300	205
2016	186	290	144	185

[a]Data from the U.S. Bureau of Labor Statistics.

To provide a measure of change in forestry costs and commodity prices, the average annual percent change was calculated in both nominal and real terms for each cost and commodity price index. Given that the PPI for all commodities was most commonly published as a measure of inflation in the Forest Farmer/Forest Landowner cost and cost trends studies, it was used to measure the average inflation rate between 1982 and 2016. The average real rate of change for each practice was calculated using the inflation rate and nominal average rate of change for each cost and commodity index.

RESULTS AND DISCUSSION

Cost Change

Table 4 reports the average annual percent change in the cost of forestry practices in the South over a 34-year period. Though the costs of all the practices rose in nominal terms, only the cost of four practices rose in real terms. Controlled burning and timber cruising real costs increased the most, while precommercial thinning also showed a notable increase. The real cost of marking trees for harvesting rose only slightly.

The costs of all other practices decreased at least slightly. The real cost of mechanical site preparation decreased the most, however given the importance of the base year in determining the average rate of change, it is necessary to mention the possibility that the average in 1982 was weighted towards more intensive, and thus more expensive treatments. For instance, the average in 1982 was at least 17 percent higher in nominal terms than the average cost reported over the course of the next four studies. Though fuel prices did decrease during this period, it is unlikely that they had that dramatic of an effect. In addition, Straka and Watson (1985) mention that the way mechanical site preparation costs were reported was changed for the 1984 study in order to get more accurate results, suggesting that the value for 1982 may have been somewhat inflated.

Forestry practices as a whole, as indicated by the SFPCI, increased at a real average rate of less than a tenth of a percent annually. However, real costs of forestry labor as indicated by the SFEWI rose steadily at an average annual rate of 1.33 percent. To put this in perspective, the cost for all the labor-intensive practices also increased. The no. 2 diesel index decreased slightly at a real rate of 0.73 annually, and the more mechanically intensive practices most associated with fuel costs, slightly decreased annually on average. Figure 1 illustrates the real change of the SFEWI in relation to that of the SFPCI and No. 2 diesel price index.

Table 4—Nominal and real cost change for southern forestry practices, 1982–2016

Practice	Nominal cost change (%)	Real cost change (%)
Controlled burning	5.64	3.75
Herbicide application	1.59	-0.23
Timber cruising	4.77	2.89
Timber marking	2.19	0.36
Mechanical site preparation	0.63	-1.17
Hand planting	2.71	0.87
Machine planting	1.52	-0.30
Precommercial thinning	3.52	1.66
Fertilization	1.76	-0.06
Southern forest practice cost index	1.84	0.02
Southern forest employee wage index	3.18	1.33
Producer Price Index[a]	1.83	—
No. 2 diesel fuel price index	1.08	-0.73

[a]Change in producer price index was used as the measure of inflation and the value reported as nominal is the average annual inflation rate.
— = The real rate of change for this index is not applicable.

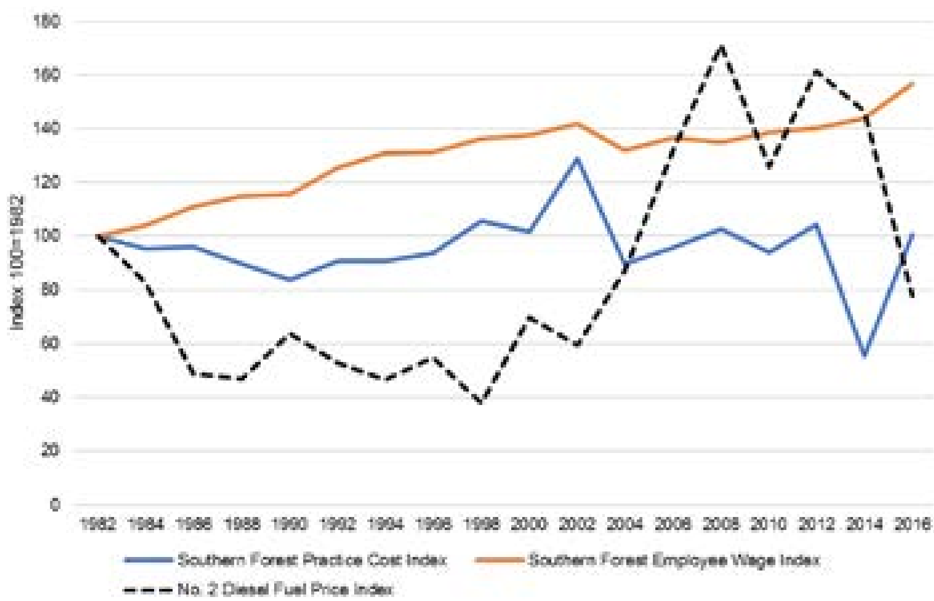

Figure 1—Real change in the Southern Forest Practice Cost Index (SFPCI), Southern Forest Employee Wage Index (SFEWI), and No. 2 Diesel Fuel Price Index.

Because some practices have continued to increase in real cost provides evidence for the importance of cost-share programs and other incentives that provide affordable means for smaller-scale timber producers to implement important silvicultural measures. However, a number of practices have not increased, and assuming these trends continue, it is unlikely that the cost of intensive silviculture as a whole will become markedly more expensive. Practices that continue to decline or remain steady in price could be potentially substituted in some cases for practices that continue to become more expensive. For example, controlled burns still cost less per acre than herbicide applications, and can achieve similar results (Maggard and Barlow 2017). Therefore, the liability associated with burning and the potential necessity of multiple burns to achieve similar results (Wigley and others 2002), combined with the decreasing cost of herbicide application, could make herbicide use a more attractive investment. At the very least, it is possible that the decrease in some costs may subsidize the increase in others, effectively maintaining an affordable basket of forest management practices.

Cost Component Analysis

Correlation analysis indicates moderate to strong relationships between labor and/or fuel costs and changes in certain forestry practices costs. The correlation coefficients for these results are listed in table 5. The costs of all practices except herbicide application were moderately to strongly correlated with forestry wages. The fact that the costs of hand planting and controlled burning were highly correlated with forestry wages is logical given the inherent labor intensiveness of these practices, and the fact that the majority of other practices were also correlated with forestry wages makes sense given that all forestry practices are somewhat labor intensive (Belli and others 1993).

Most practices had a correlation with diesel prices. This correlation was highest in fertilization and machine planting, which is expected given the mechanical intensity of these practices. Controlled burning often incorporates the use of bulldozers along with manpower, so this correlation with diesel prices makes sense. However, the fact that costs of less mechanically intensive practices such as planting by hand, timber marking, and timber cruising also had correlations with diesel fuel prices, is less logical. Upon investigation, diesel prices and forestry wages were found to be correlated, so it is possible that costs for non-mechanical practices could show correlations with diesel prices without a direct relationship. Due to this issue, if fuel prices or forestry wages were to be included as variables in the prediction of forestry practices costs, it would be important to recognize whether the nature of the practice made this appropriate.

Table 5—R values for correlations between forest practices costs and Southern Forest Employee Wage Index (SFEWI) and diesel price index

Forestry practice cost component	Controlled burning	Herbicide application	Timber cruising	Tree marking	Mechanical site preparation	Hand planting	Machine planting	Precommercial thinning	Fertilization	Southern forest practice cost index
Labor	0.90	-0.25	0.73	0.62	0.60	0.96	0.81	0.61	0.84	0.80
No. 2 Diesel	0.79	-0.52	0.60	0.70	0.51	0.83	0.88	0.19	0.89	0.69
Herbicide	—	-0.52	—	—	—	—	—	—	—	—
Fertilizer	—	—	—	—	—	—	—	—	0.92	—

— = Not applicable.

Herbicide application costs showed a moderate negative correlation with diesel fuel prices. However, it is unlikely that higher diesel prices would decrease the cost of herbicide application. Rather, it is more likely that herbicide application costs declined or increased for other reasons, at times when diesel fuel prices happened to be doing the opposite. For example, as diesel fuel prices declined in the early to mid-1980s, supply factors may have affected the cost of forestry chemicals such as the restriction of 2,4,5-T for forestry use in 1979 (Belli and others 1993, Fox and others 2007). Likewise, herbicide prices may have dropped due to the expiration of patents on some herbicides in the early and mid-2000s (Lunsford 2018, Woodburn 2000), a time period that happened to experience increases in diesel prices. However, the fact that herbicide application costs for 1990-2016 did not show a logical correlation with herbicide chemical costs during that time period may be due to the fact that, aside from glyphosate and 2-4-D, the index used represents a suite of herbicides more commonly used in agriculture than in forestry.

Despite the fact that the index used for fertilizer costs was also of an agricultural nature, fertilization practices had a strong correlation with fertilizer prices. This correlation is logical and has been supported by past cost studies (Belli and others 1993). It may be that the correlation was stronger than that between agricultural herbicides and forest herbicide application due to the fact that fertilizer components are often more similar between forestry and agriculture than herbicide components.

Other Influences

Although practices often dependent on the use of equipment, including herbicide application and mechanical site preparation, did not show stronger correlations with diesel fuel prices does not mean that the costs of these practices are not affected by them. It may, however, mean that for some practices other factors may at times have overshadowed the influence of labor costs and fuel prices. One factor playing a substantial part in influencing these costs may be changes in general forestry industry and market conditions. In the case of mechanical site preparation, it has been noted that significant moderation in costs in the late 1980s and early 1990s may have been due to an over-abundant supply of contractors resulting from many landowners switching to chemical site preparation (Dubois and others 2001). In addition, Smidt and others (2005) speculated that many contractors using mechanical-intensive methods may had borne the cost of increased fuel prices in order to remain competitive during a period of lower demand brought on by an increasing scrupulous forestry market. Likewise, during periods of intense sawtimber and pulpwood demand, the high demand for forestry practices may have influenced higher practices costs (Dubois and others 1999).

Another example of possible additional factors playing a role in influencing costs can be found with controlled burning. Though prescribed burning costs showed logical correlations with increasing forestry wages, burning costs have increased substantially faster than forestry wages. There is no doubt that over the years, increased liability, as well as regulations regarding smoke management, has played a role in driving up these costs (Dubois and others 2001). These factors become magnified as urban and suburban areas continue to encroach upon managed forests.

There are many complexities surrounding forestry practices cost components, market conditions, contractor supply, and regulations that likely influence the cost of forestry practices. Given the relatively constant nature of the SFPCI, and assuming markets for wood continue to be viable, it is not likely that costs associated with timber management will be a prohibitive factor. However, certain costs continue to change and in order to understand their impact on timber investment profitability it would be valuable to model how common management scenarios may respond to the noted rates of change in cost.

CONCLUSIONS

Understanding the costs associated with practicing forestry is important in assessing the potential risk and reward of any forestry investment. As important as it is to have this cost data available to land managers, it is perhaps as important to understand the trends associated with changes in the costs of these practices. Predictions regarding the future capital necessary to invest in forestry practices can be made more accurate, or at least better assessed, through understanding past cost trends and the forces driving them. Through analyzing published cost data, one can draw some conclusions regarding how the cost of specific forestry practices change in relationship to inflation, and whether intensive forestry is going to be harder to profit from in the future. Though the real cost of intensive forestry practices as a whole has changed little on average over the last 34 years, the real individual costs of several labor-driven practices have increased, indicating that some small-scale producers may continue to need cost-share assistance for certain practices, such as precommercial thinning and/or prescribed burning.

The relationships between the costs of forestry practices, labor, diesel fuel, and other variable cost inputs has been described in the literature and we have shown that the use of correlation analysis can be useful in some cases to strengthen the evidence of these relationships. However, though trends in variable costs undoubtedly influence change in the cost of forestry practices, other important market factors, like changes in forest management technology, changes in the forestry industry, and economies of scale, likely play an important role as well. Future research could focus on the role of historic forestry practices demand, as well as variable cost inputs, in influencing forestry practice costs. In addition, given that this study has demonstrated that the cost of several practices are indeed changing, it would be valuable to use these rates to assess forest investment sensitivity to change in forestry practices costs.

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